FAME Observatory Contamination Control

Mark Boies

Contamination Control

Research Support Instruments

(301) 306-0010

boies@researchsupport.com

Scope of Contamination Control Efforts

- Requirements Identification
  - Review, Understand, Analyze Instrument Requirements
  - Contribute to the Contamination Section of Spacecraft to Instrument ICD
  - Develop Observatory Processing Method
    - Maintain Instrument Cleanliness
    - Maximize Ease of Spacecraft Access
- Provide Program Guidance
  - Material Selection
  - Bakeout Procedures
  - System Processing
  - Material and Process Waivers
- Maintain Instrument/Observatory Cleanliness
  - Implement Procedures
    - Spacecraft Processing
    - Instrument Purge/Bagging
  - Test/Verify Surfaces
  - Clean Surfaces (As Required)

Requirements

- **Ensure Proper Techniques and Methods Are Used in Subsystem Development for Contamination Mitigation**
- **Maintain Instrument Cleanliness**
- **Process Observatory in a "Controlled Environment"**
  - **Typically a Class 10,000 or Better Location**
  - **Occasional Class 100,000 – 300,000 Facility**
    - **Crane Operations**
    - **Environmental (Vibration, Acoustic, TVAC) Testing**
    - **Mass Properties**

Contamination Control Design

- **Integral Instrument Purge**
  - **Purge Flow Sufficiently High to Maintain Class 100 or Better Environment**
    - **Opt 1: Class 100 Requires 250 Air Changes an Hour (Impractically High)**
    - **Opt 2: Magnehelic Measurement to Keep Instrument Internal Pressure 0.2 Psi Higher Than External Pressure**
    - **Soln: 24-30 Air Changes an Hour With Restricted Vents Will Achieve +0.2 PSI**
  - **Design Air Flow to Travel From Most Sensitive (FPA) to Least Sensitive (Baffle) Elements**
- **Baffle Design to Eliminate Spacecraft Field of View**
  - **Re-Encounter Rates Are Exceedingly Low**
  - **Less Than 1 Part in 10^6 for Molecular Elements**
- **Baffle Covers**
- **Establishment of Micro-Environments**
  - **Develop an Environmental Cleanliness Contour Around the Instrument**
    - **Maintain Cleanest Environments Nearest to Instrument**
    - **Key Issue Is the Flow of "Clean" Air Over the Instrument**
    - **A Downstream Polluter Will Not Effect the Upstream Environment**
  - **Vertical Laminar Airflow Tent**
  - **Appropriate Gowning Requirements**

Contamination Control Elements

- **NCST-ICD-FM001 Spacecraft Bus to Instrument Interface Control Document (ICD)**
- **NCST-D-FM007, *FAME Contamination Control Plan – 4 Elements***
  - **Materials Selection**
  - **Instrument/Subsystem Design and Development**
  - **Observatory Integration and Test**
  - **Launch Site Operations**
- **Instrument Contamination Control Plan, P546614**
- **Ancillary Documents**
  - **Bakeout Procedure**
  - **Cleanliness Testing Methods and Procedures**
  - **Spacecraft Cleaning Procedure**
- **Surface Cleanliness Verification**
  - **Tape Lifts, Witness Plates, Alcohol Rinse, Visual Inspections**
- **Common Sense**
  - **Get Scientists, Engineers, and Technicians to Agree to Common Effort**
  - **Training to Understand Concerns**
  - **Think and Act . . . Do Not Push Limits of Procedural Rules**

Observatory Contamination Control

- Keep Instrument Bagged at All Times Except TVAC
- Maintain GN2 Purge on Instrument Until Launch
  - Very Few Disconnections Are Anticipated
- Minimize the Number of Times the Instrument Aperture Doors Are Opened
- Precondition the TVAC Chamber Prior to Test, and Monitoring Outgassing With TCQM & RGA
- Maintain Instrument and Observatory in Cleanest Possible Environment (Cleanroom)
  - Ensure Personnel Training and Adherence to Procedures
- Bus Contamination Control Methods

Bus Contamination Control

- FAME Bus Structure Built Under Normal High Bay Conditions
  - Interfaces Wiped Down With Solvent and Lint Free Wipes Before Assembly
  - Harness Is Separately Baked Out (Higher Temperature Possible)
- Structure Is Cleaned Prior to Entering Clean Room for Propulsion System Integration
- Following RCS Integration, Structure Leaves Clean Room and Is Placed in Clean Tent in High Bay for Subsystem Integration
- After Subsystem Integration, Bus Is Baked Out in Vacuum Chamber
  - Maintained Until TQCM Indicates Acceptable Outgassing Rate
- Bus Leaves Chamber and Returns to Clean Room (or Clean Tent)
- Instrument and Bus Must Leave Clean Room for Physical Installation
  - Do Not Have Crane in Any of NRL's Clean Rooms
  - Instrument Is Bagged and Purged, Bus Is Covered With Llumalloy
- Observatory Is Returned to Clean Room for Electrical Integration

Bldg A59 Clean Room Facilities

Facility	Best Cleanliness Level	Interior Size (L x W x H)	Entrance Size (W x H)
New Clean Room	Class 1000	44’ x 23.7’ x 20’	18’ x 18’
Old Clean Room	Class 100*	35’ x 29’ x 10.5’	12’ x 9.8’
Fixed Clean Tent	Class 100	17’ x 17’ x 18’	16’ x 9’
Large Portable Clean Tent	Class 100	15’ x 15’ x 21’	15’ x 20’
Small Portable Clean Tent	Class 1000	12’ x 6’ x 8’	12’ x 7.5’

*Horizontal Flow Clean Room, Rating Applies Directly in Front of Filter Bank Only

FAME Observatory Dimensions:

- Height = 8.0 Feet (on Dolly)
- Diameter = 9.0 Feet

Backup

Preliminary Design Description

- **Goal:** Maintain Optic Performance
- **Heritage:** All Spacecraft Surfaces Do Not Need to Have the Same Cleanliness Level Provided They Do Not Directly View Each Other
- **Process:**
  - Maintain Identical Internal and External Instrument Surfaces During Instrument Development
  - Upon Observatory I&T, Instrument Purge Maintains Optic Cleanliness
    - Double Bagging Minimizes Contaminant Buildup on External Surfaces
  - Final Cleaning at Launch Site Processing Facility and Pad Close-Out
  - Minimize Surface Class Differential at Launch, Maximize Program Resources